C. Segment B - New Technologies Supporting Linkages
(3) Session B2- Linking Statically Through Data Sharing
a. Introduction Summary
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Linking Simulation Statically Via Data Sharing

Robert Lutz
Johns Hopkins University/ Applied Physics Laboratory
13-N414
11100 Johns Hopkins Road
Laurel, MD 20723

Military analysts have long utilized models and simulations as a means of performing system effectiveness/tradeoff studies and studying operational issues such as force deployment/employment options. There is considerable diversity among the types of models and simulations currently in use across DoD, since the DoD M&S user community is itself quite diverse. For instance, acquisition program managers for a specific type of subsystem may require highly detailed engineering simulations to evaluate design options, while a CINC may require highly aggregated simulations to study sustainment issues over an extended military campaign. In addition to level of granularity, simulations may also differ in terms of functional area (strike, anti-air warfare, theater missile defense, …) and application area (analysis, training, RD&E, …).

Since the development of DoD simulations have historically tended to be "stovepiped" into satisfying very particular needs, there has been little regard in the past for how a simulation may be reused outside of the domain for which it was designed. This has resulted in an explosion in the numbers of models and simulations across DoD, many of which possess similar features and functionalities that were unnecessarily redesigned and reimplemented in each new M&S program. In recognition of the need to improve the efficiency by which existing M&S resources are utilized across DoD, the DoD Modeling and Simulation Master Plan (October, 95) has given new emphasis and visibility to technologies and processes which facilitate interoperability between simulations, and reuse of simulation components. A major goal in the plan is to support and encourage the composition of new simulation systems based on linking together existing simulation resources in innovative ways.

There are two main categories of linkages which can be established between existing simulation systems for analytic purposes. First, simulations can be linked across functional areas to investigate issues of broader scope than any one simulation could address in isolation. This process is called *horizontal integration.* For instance, a naval warfare simulation could be linked with an army ground warfare simulation to investigate

the synergy of ground-sea forces in littoral operations. The other main category of simulation-to-simulation linkage involves integrating models across levels of granularity within a given domain. This is called *vertical integration.* For instance, an aggregated air defense simulation may want to link to high-resolution representations of ESM systems/subsystems to study the effect of the performance of these systems on the overall mission.

For either horizontal or vertical integration, there are three main options for how to enact the required linkages. The first option is to directly integrate the required capabilities of one model into another. This approach of creating a single simulation out of many, while perhaps leading to a robust and efficient runtime solution for the specific problem at hand, tends to require extensive software changes every time the problem changes even slightly, and is generally unmaintainable over time. The second approach is to link simulations statically through the sharing of data. In this approach, the output of one simulation becomes an input for another. This process can be made to be completely automated (via an integrated modeling environment) for well-defined problem domains, but is more likely to require some intervention by an analyst to maintain data consistency. The third approach is to link simulations dynamically at runtime. This can be accomplished through custom model interfaces developed for a particular domain, or can be more generalized communications protocols intended to serve a broader user base.

Historically, the analytic community has relied on static data sharing linkages whenever multi-simulation integration was required. There are many significant advantages to this approach. First of all, it is a proven robust technique with low risk to the program conducting the study. Static linkages provide a viable means of linking simulations that would be difficult to link dynamically, such as simulations with different time management schemes. Linking simulations statically via data sharing also provides an opportunity for direct analyst intervention into the analysis process. Analysts may examine and (if necessary) manipulate the data produced at each stage of the study, providing transparency into and analyst control throughout the investigation. Possible disadvantages to this technique includes the fact that it tends to be resource intensive, it is dependent on the willingness of sponsoring agencies to share data, and it normally requires (in the absence of data standards) rebuilding the output data sets produced by a simulation whenever the intended user of the data set changes.

Although the issues related to this technique of linking simulations are many, this session will focus on the examination of the following questions:

- What activities are taking place within DoD to develop standards for static data exchange among analytic simulations.

- What experimentation has been performed with new technologies and methodologies to support nonruntime data exchange among analytic simulations.

The first paper in this session will focus on reviewing the main problems and issues associated with exchanging data statically among dissimilar simulations, and what steps are being taken within the DoD Data Standardization Program to address these problems. The second paper in this session will provide a case study of an integrated process that has been established to manage the exchange of data between independent simulations, within a given analytic methodology.